# MODAS—MASDA Integration

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## LONG-TERM GOALS

Our long-term goal is to assess the impact of temporal and spatial dynamics of oceanographic and meteorological factors on Navy sensors, systems, and operations. We will continue to improve our ability to exploit advances in remote sensing and climatology in the development of environmentally sensitive algorithms to improve ASW effectiveness in shallow-water, littoral regions.

## OBJECTIVES

Our FY02 objective was to fine-tune MODAS Adaptive Sampling Decision Aid (MASDA) strategies to simultaneously reduce the number of in-situ measurements and improve MODAS nowcast accuracy.

## APPROACH

Our approach has been to acquire high-density in-situ ocean temperature (AXBT) datasets worldwide, and create MODAS first-guess fields (with and without satellite sea-surface temperature data) matched for location and date. Various adaptive strategies based on MODAS's companion uncertainty field are then used to choose variously-sized sets of the AXBT data for ingestion into the MODAS optimum interpolation package, to create an improved nowcast. As a control, multiple sets (of various sizes) of the AXBT data based on a subjective method (very similar to typical practice) are similarly ingested into MODAS. All the nowcasts (including the first-guess fields themselves) are compared to the full in-situ dataset (which is the ground truth, or baseline, for the study). This process determines the typical error reduction (and for the control method, its uncertainty) available as a function of ingested dataset size and selection strategy.

## WORK COMPLETED

So far, four strategies have been tested. The Sequential Explicit (SE) approach recommends each additional measurement location based solely on the MODAS-recomputed temperature uncertainty using all previous measurement locations, *i.e.*, choose the best location, assess the impact, choose the next, *etc*. The Sequential Implicit (SI) approach recommends each additional measurement location after determining the MODAS-recomputed temperature uncertainty fields for each candidate location plus all previous measurement locations, *i.e.*, assess the impact for each single location, choose the best location, assess the impact for each remaining location, *etc*. The Combinatorial Explicit (CE) approach recommends a set of measurement locations (drawn from the set of all possible combinations) based on their combined initial uncertainty. The Combinatorial Implicit (CI) approach first winnows the enormous number of potential combinations to a manageable number based on combined initial uncertainty, and then recommends one set of measurement locations after determining

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14. ABSTRACT
**Our long-term goal is to assess the impact of temporal and spatial dynamics of oceanographic and meteorological factors on Navy sensors, systems, and operations. We will continue to improve our ability to exploit advances in remote sensing and climatology in the development of environmentally sensitive algorithms to improve ASW effectiveness in shallow-water, littoral regions.**

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the MODAS-recomputed temperature uncertainty fields for each candidate set, *i.e.*, choose many sets of *N* locations based on combined initial uncertainty, then assess the combined impact of each set, and then select the best set.

## RESULTS

All adaptive strategies out-performed the subjective strategy commonly used, and the combinatorial approaches do so more consistently. See Figures 1 and 2. Figure 1 shows that the advantage of MASDA strategies over the subjective method is strongest at very low sampling densities (1-4 AXBTs). There is no consistent winner between the two combinatorial methods, however, since each out-performs the other (often only slightly) in about half of the cases, whether judged by average error reduction (Figure 1) or by fraction of hand-picked sets out-performed (Figure 2). The CE method is vastly less computationally expensive than the CI method, and so it is the winner on practical grounds.

## IMPACT/APPLICATIONS

All adaptive strategies tested outperform the standard subjective methods in common use, so it is possible to achieve better nowcasts and simultaneously reduce the number of AXBTs used, saving money and time. Until one method pulls clearly ahead of the other adaptive strategies, however, choosing among them will be based primarily on computational efficiency.

## TRANSITIONS

MASDA methodologies are not yet mature enough for transition; however, we are working with the TAMDA Program Office for a future transition.

## RELATED PROJECTS

The present effort is related to TAMDA.

## PUBLICATIONS

[a] Collins, Mona J., DelBalzo, Donald R., Barron, Charlie N., and Rike, Erik R., “MASDA adaptive AXBT sampling to improve MODAS nowcast accuracy,” *Journal of Atmospheric and Oceanographic Technology*. (in security review)

[b] Collins, Mona J. and DelBalzo, Donald R., “Impact of equidistant AXBT sampling on MODAS nowcast accuracy,” *Journal of Atmospheric and Oceanographic Technology*. (in security review)

[c] Collins, Mona J., DelBalzo, Donald R., and Barron, Charlie N., “MASDA–MODAS adaptive sampling aid,” *Proceedings* of the 2002 MTS/IEEE Conference on Oceans, 29-31 October 2002, Biloxi, MS. (in press)

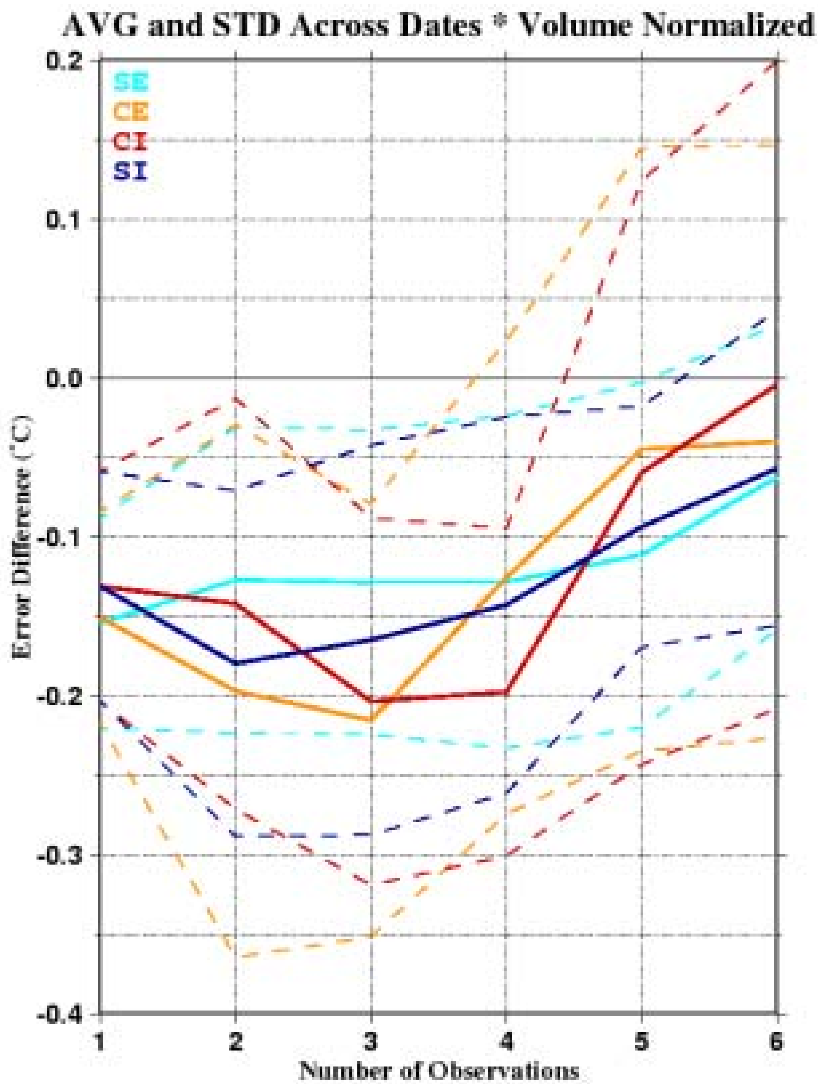


***Figure 1. Average (solid) and STD range (dashed) of change in error as a function of number of observations for four adaptive selection strategies compared to populations created by subjective method. Subjective method is zero line, and negative values represent improvement. Sequential Implicit (SI) method is dark blue, Sequential Explicit (SE) method is light blue, Combinatorial Implicit (CI) method is red, and Combinatorial Explicit (CE) method is orange. [All average curves stay below zero, but criss-cross.]***

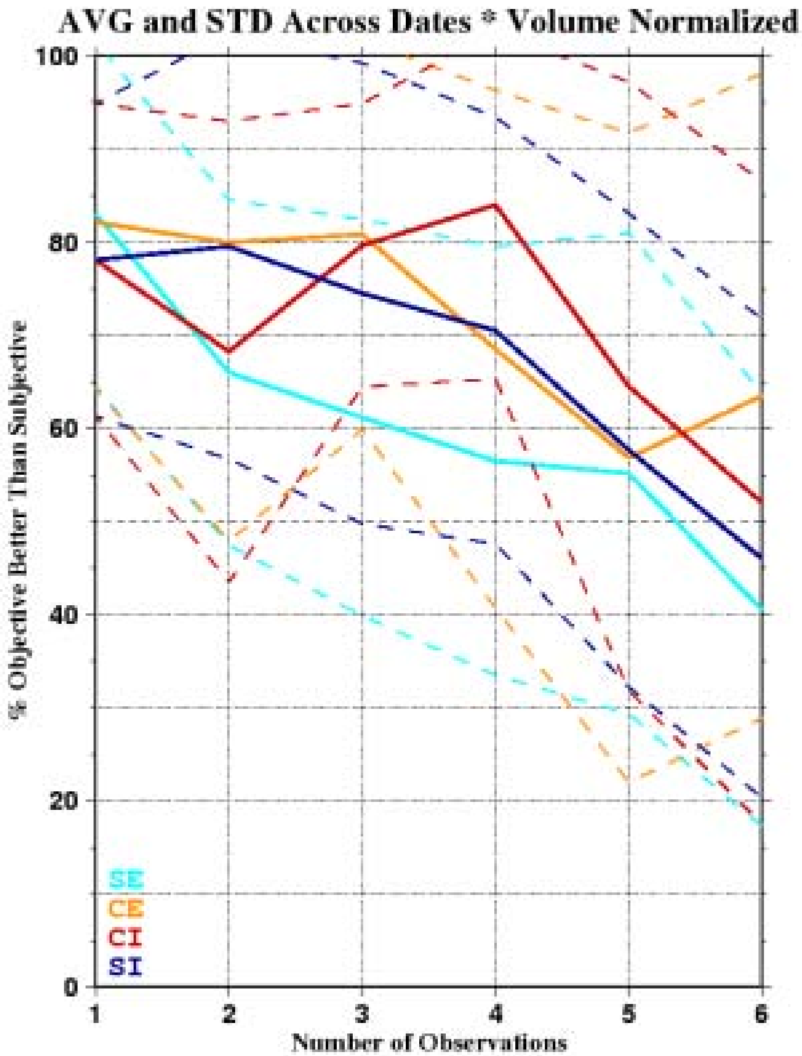


***Figure 2. Fraction of subjective datasets outperformed as a function of number of observations for four adaptive selection strategies. Sequential Implicit (SI) method is dark blue, Sequential Explicit (SE) method is light blue, Combinatorial Implicit (CI) method is red, and Combinatorial Explicit (CE) method is orange.***

***[All curves start near 80% for one AXBT and trend down to near 50% for 6 AXBTs. ]***